New Hampshire Volunteer Lake Assessment Program

2003 Interim Report for
Kezar Lake
North Sutton

NHDES
Water Division
Watershed Management Bureau
29 Hazen Drive
Concord, NH 03301

NEW HAMPSHIRE DEPARTMENT OF **Environmental Services**

OBSERVATIONS & RECOMMENDATIONS

After reviewing data collected from **KEZAR LAKE, NORTH SUTTON,** the program coordinators have made the following observations and recommendations:

As part of the state's lake survey program, DES biologists performed a comprehensive lake survey on **KEZAR LAKE** this summer. Publicly-owned recreational lakes/ponds in the state are surveyed approximately every ten to fifteen years. In addition to the tests normally carried out by VLAP, biologists tested for certain indicator metals and nitrogen, created a map of the lake/pond bottom contours (referred to as a bathymetric map), and mapped the abundance and distribution of the aquatic plants along the shoreline. DES biologists will also sample the lake/pond once during the Winter of 2003-2004. Some data from this lake survey have been included in this report and has been added to the historical database for your lake/pond. If you would like a complete copy of the raw data from the lake survey, please contact the DES Limnology Center at (603) 271-3414 or (603) 271- 2658. A final report should be available in 2005 and a copy will be available at any state library.

Lake testing in 2003 showed that the quality of Kezar Lake met the standards required by the Court Consent Decree. Specifically, ten weekly sampling rounds were conducted between the last week in June and Labor Day (a total of 13 sampling rounds were conducted for the entire summer season). Furthermore, during the sampling season, there were not four chlorophyll-a values greater than or equal to 10 ug/L, and there were not four transparency values less than 2 meters. Specifically, there were three chlorophyll-a sample concentrations greater than 10 ug/L, and there were no transparency values less than 2 meters. As a requirement of the consent decree, sampling will be conducted during the 2004, the final year of monitoring required by the Consent Decree.

We recommend that Kezar Lake continue to be monitored on at least a monthly basis during the summer (at least once in June, July, and August) after the consent decree expires. It is important to continue to sample the lake on a routine basis so that any changes in water quality can be detected early.

FIGURE INTERPRETATION

- **Figure 1 and Table 1:** The graphs in Figure 1 (Appendix A) show the historical and current year chlorophyll-a concentration in the water column. Table 1 (Appendix B) lists the maximum, minimum, and mean concentration for each sampling season that the lake/pond has been monitored through the program.

  Chlorophyll-a, a pigment naturally found in plants, is an indicator of the algal abundance. Because algae are usually microscopic plants that contain chlorophyll-a, and are naturally found in lake ecosystems, the chlorophyll-a concentration measured in the water gives an estimation of the algal concentration or lake productivity. **The mean (average) summer chlorophyll-a concentration for New Hampshire's lakes and ponds is 7.02 ug/L.**

  The current year data (the top graph) show that the mean monthly chlorophyll-a concentration ***increased*** from June to July, and then ***remained relatively stable*** from July to September. The mean chlorophyll-a concentration in June was ***less than*** the state mean, while the mean concentration in July, August, and September was ***slightly greater than*** the state mean.

  It is important to point out that the chlorophyll concentration was ***elevated*** on the July 7, July 14, and August 25 sampling events (10.1, 10.05, and 11.96 mg/m^3, respectively).

  The historical data (the bottom graph) show that the 2003 chlorophyll-a mean is ***approximately equal to*** the state mean.

  Overall, visual inspection of the historical data trend line (the bottom graph) shows a ***decreasing (meaning improving)*** in-lake chlorophyll-a trend since monitoring began in 1988. In the 2004 annual report, we will conduct a statistical analysis of the historical data to objectively determine the percent change per year of the annual mean chlorophyll-a concentration since monitoring began.

  While algae are naturally present in all lakes/ponds, an excessive or increasing amount of any type is not welcomed. In freshwater lakes/ponds, phosphorus is the nutrient that algae depend upon for growth. Algal concentrations may increase with an increase in nonpoint sources of phosphorus loading from the watershed, or in-lake sources of phosphorus loading (such as phosphorus releases from the sediments). Therefore, it is extremely important for volunteer monitors to continually educate residents about how activities within the watershed can affect phosphorus loading and lake/pond quality.

- **Figure 2 and Table 3:** The graphs in Figure 2 (Appendix A) show historical and current year data for lake/pond transparency. Table 3 (Appendix B) lists the maximum, minimum and mean transparency data for each sampling season that the lake/pond has been monitored through the program.

  Volunteer monitors use the Secchi-disk, a 20 cm disk with alternating black and white quadrants, to measure water clarity (how far a person can see into the water). Transparency, a measure of water clarity, can be affected by the amount of algae and sediment from erosion, as well as the natural colors of the water. **The mean (average) summer transparency for New Hampshire's lakes and ponds is 3.7 meters.**

  The current year data (the top graph) show that the mean monthly in-lake transparency ***remained relatively stable*** from June to July, and then ***decreased slightly*** from July to September.

  Overall, the visual observation of the historical data trend line (the bottom graph) shows that the mean annual in-lake transparency has ***remained stable*** since monitoring began. Specifically, the in-lake transparency has fluctuated slightly between approximately **2** and **3 meters** since 1988. The slight tea color of the lake water likely explains why the transparency has not significantly increased as one would expect given the decreased in chlorophyll concentration.

  As discussed previously, in the 2004 annual report, we will conduct a statistical analysis of the historical data to objectively determine if there has been a significant change in the annual mean transparency since monitoring began.

  Typically, high intensity rainfall causes erosion of sediments into lakes/ponds and streams, thus decreasing clarity. Efforts should continually be made to stabilize stream banks, lake/pond shorelines, disturbed soils within the watershed, and especially dirt roads located immediately adjacent to the edge of tributaries and the lake/pond. Guides to Best Management Practices designed to reduce, and possibly even eliminate, nonpoint source pollutants, such as sediment loading, are available from DES upon request.

- **Figure 3 and Table 8:** The graphs in Figure 3 (Appendix A) show the amounts of phosphorus in the epilimnion (the upper layer) and the hypolimnion (the lower layer); the inset graphs show current year data. Table 8 (Appendix B) lists the annual maximum, minimum, and median concentration for each deep spot layer and each tributary since the lake/pond has joined the program.

Phosphorus is the limiting nutrient for plant and algae growth in New Hampshire's freshwater lakes and ponds. Too much phosphorus in a lake/pond can lead to increases in plant and algal growth over time. **The median summer total phosphorus concentration in the epilimnion (upper layer) of New Hampshire's lakes and ponds is 11 ug/L. The median summer phosphorus concentration in the hypolimnion (lower layer) is 14 ug/L.**

The current year data for the epilimnion (the top inset graph) show that the mean monthly phosphorus concentration ***remained relatively stable*** from June to September.

The historical data show that the 2003 mean epilimnetic phosphorus concentration is ***slightly greater than*** the state median.

The current year data for the hypolimnion (the bottom inset graph) show that the mean monthly phosphorus concentration ***decreased*** from June to July, ***increased*** from July to August, and then ***decreased*** from August to September. The mean monthly phosphorus concentration was ***greater than*** the state median for each month.

It is important to point out that the annual mean hypolimnetic phosphorus concentration this year was the ***highest*** annual mean (27 ug/L) since monitoring began. The hypolimnetic phosphorus concentration was particularly ***elevated*** on the June 30 and August 4 sampling events (59 and 60 ug/L, respectively). The turbidity of these samples was also ***elevated*** (2.47 and 6.3 NTUs, respectively). This suggests that the lake/pond bottom may have been disturbed by the anchor or by the Kemmerer Bottle while sampling. When the lake/pond bottom is disturbed, sediment, which typically contains attached phosphorus, is released into the water column. *When collecting the hypolimnion sample, please check to make sure that there is no sediment in the Kemmerer Bottle before filling the sample bottles.*

Overall, visual observation of the historical data show that the phosphorus concentration in the epilimnion (upper layer) and the hypolimnion (lower layer) has ***decreased,*** meaning *improved*, since monitoring began in 1988.

One of the most important approaches to reducing phosphorus loading to a waterbody is to continually educate watershed residents about its sources and how excessive amounts can adversely impact the ecology and value of lakes and ponds. Phosphorus sources within a lake or pond's watershed typically include septic systems, animal waste, lawn fertilizer, road and construction erosion, and natural wetlands.

TABLE INTERPRETATION

- **Table 2: Phytoplankton**
  Table 2 (Appendix B) lists the current and historical phytoplankton species observed in the lake/pond.

  The dominant phytoplankton species observed this year were ***Melosira* (a diatom)** in June, ***Mallomonas* (a golden-brown algae)** in July, ***Spirulina* (a cyanobacteria)** in August, and ***Melosira* (a diatom)** in September.

  Phytoplankton populations undergo a natural succession during the growing season (Please refer to the "Biological Monitoring Parameters" section of this report for a more detailed explanation regarding seasonal plankton succession). Diatoms and golden-brown algae are typical in New Hampshire's less productive lakes and ponds.

- **Table 2: Cyanobacteria (Blue-green algae)**
  Small amounts of the cyanobacterium ***Anabaena*** was observed in the June plankton sample. In addition, small amounts of the cyanobacterium ***Oscillatoria*** was observed in the July, August and September plankton sample.

  These species, if present in large amounts, can be toxic to livestock, wildlife, pets, and humans.

  Cyanobacteria can reach nuisance levels when excessive nutrients and favorable environmental conditions occur. During September of 2003, a few lakes and ponds in the southern portion of the state experienced cyanobacteria blooms. This was likely due to nutrient loading to these waterbodies. As mentioned previously, many weeks during the Spring and Summer of 2003 were rainy, which likely resulted in a large amount of nutrient loading to surface waters.

  The presence of cyanobacteria serves as a reminder of the lake's/pond's delicate balance. Watershed residents should continue to act proactively to reduce nutrient loading into the lake/pond by eliminating fertilizer use on lawns, keeping the lake/pond shoreline natural, re-vegetating cleared areas within the watershed, and properly maintaining septic systems and roads.

  In addition, residents should also observe the lake/pond in September and October during the time of fall turnover (lake mixing) to document any algal blooms that may occur. Cyanobacteria (blue-green algae) have the ability to regulate their depth in the water column by producing or releasing gas from vesicles. However, occasionally lake mixing can affect their buoyancy and cause them to rise to the surface and bloom. Wind and currents tend to "pile" cyanobacteria into scums that accumulate in one section of the lake/pond. If a fall bloom occurs, please contact the VLAP Coordinator.

- **Table 4: pH**

  Table 4 (Appendix B) presents the in-lake and tributary current year and historical pH data.

  pH is measured on a logarithmic scale of 0 (acidic) to 14 (basic). pH is important to the survival and reproduction of fish and other aquatic life. A pH below 5.5 severely limits the growth and reproduction of fish. A pH between 6.5 and 7.0 is ideal for fish. The mean pH value for the epilimnion (upper layer) in New Hampshire's lakes and ponds is **6.5**, which indicates that the surface waters in state are slightly acidic. For a more detailed explanation regarding pH, please refer to the "Chemical Monitoring Parameters" section of this report.

  The mean pH at the deep spot this season ranged from **6.16** in the hypolimnion to **6.43** in the epilimnion, which means that the water is ***slightly acidic.*** When organic material near the lake bottom is decomposed, acidic byproducts are produced, which likely explains the lower pH (meaning higher acidity) in the hypolimnion.

  Due to the presence of granite bedrock in the state and the deposition of acid rain, there is not much that can be done to effectively increase lake/pond pH.

- **Table 5: Acid Neutralizing Capacity**

  Table 5 (Appendix B) presents the current year and historical epilimnetic ANC for each year the lake/pond has been monitored through VLAP.

  Buffering capacity or ANC describes the ability of a solution to resist changes in pH by neutralizing the acidic input to the lake. The mean ANC value for New Hampshire's lakes and ponds is **6.7 mg/L**, which indicates that many lakes and ponds in the state are "highly sensitive" to acidic inputs. For a more detailed explanation, please refer to the "Chemical Monitoring Parameters" section of this report.

  The Acid Neutralizing Capacity (ANC) of the epilimnion (the upper layer) continues to remain ***slightly less than*** the state mean. Specifically, the mean ANC this season was **4.78 mg/L**, which indicates that the lake/pond is ***critically sensitive*** to acidic inputs (such as acid precipitation).

- **Table 6: Conductivity**

  Table 6 (Appendix B) presents the current and historical conductivity values for tributaries and in-lake data. Conductivity is the numerical expression of the ability of water to carry an electric current. The mean conductivity value for New Hampshire's lakes and ponds is **62.1 uMhos/cm**. For a more detailed explanation, please refer to the "Chemical Monitoring Parameters" section of this report.

  The conductivity has ***increased*** in the lake/pond and inlets since monitoring began. In addition, the in-lake conductivity is ***much greater than*** the state mean. Typically, sources of increased conductivity are due to human activity. These activities include septic systems that fail and leak leachate into the groundwater (and eventually into the tributaries and the lake/pond), agricultural runoff, and road runoff (which contains road salt during the spring snow melt). New development in the watershed can alter runoff patterns and expose new soil and bedrock areas, which could contribute to increasing conductivity. In addition, natural sources, such as iron deposits in bedrock, can influence conductivity.

  We recommend that your monitoring group conduct stream surveys and storm event sampling along the inlet(s) with elevated conductivity so that we can determine what may be causing the increases.

  For a detailed explanation on how to conduct rain event and stream surveys, please refer to the 2002 VLAP Annual Report "Special Topic Article", or contact the VLAP Coordinator.

  It is possible that de-icing materials applied to nearby roadways during the winter months may be influencing the conductivity in the tributaries and in the lake. In New Hampshire, the most commonly used de-icing material is salt (sodium chloride). Therefore, we recommend that the inlets with elevated conductivity be sampled for chloride next season.

  Please note that there will be an additional cost for each of these samples, and these samples can not be analyzed at the satellite laboratory at Colby Sawyer College. Therefore, it would be best to collect the chloride samples during the annual biologist visit next season.

- **Table 8: Total Phosphorus**
  Table 8 (Appendix B) presents the current year and historical total phosphorus data for in-lake and tributary stations. Phosphorus is the nutrient that limits the algae's ability to grow and reproduce. Please refer to the "Chemical Monitoring Parameters" section of this report for a more detailed explanation.
  The Inlet, Lyon Brook at Trussel Ridge, and the Outlet were sampled for total phosphorus this season. The phosphorus concentration in the August 4 sample collected at **Lyon Brook at Trussel Ridge** was ***elevated*** (40 ug/L) as was the turbidity of the sample (3.9 NTUs). This suggests that the stream bottom may have been disturbed while sampling or that erosion is occurring in this portion of the watershed.

  When the stream bottom is disturbed, sediment, which typically contains attached phosphorus, is released into the water column. When collecting samples in the inlets, please be sure to sample where there the stream is flowing and where the stream is deep enough to collect a "clean" sample.

  If you suspect that erosion is occurring in this portion of the watershed, we recommend that your monitoring group conduct stream surveys and storm event sampling along this inlet. This additional sampling may allow us to determine what is causing the elevated levels of turbidity and phosphorus.

  For a detailed explanation on how to conduct rain event and stream surveys, please refer to the 2002 VLAP Annual Report "Special Topic Article", or contact the VLAP Coordinator.

- **Table 9 and Table 10: Dissolved Oxygen and Temperature Data**
  Table 9 (Appendix B) shows the dissolved oxygen/temperature profile(s) for the 2003 sampling season. Table 10 (Appendix B) shows the historical and current year dissolved oxygen concentration in the hypolimnion (lower layer). The presence of dissolved oxygen is vital to fish and amphibians in the water column and also to bottom-dwelling organisms. Please refer to the "Chemical Monitoring Parameters" section of this report for a more detailed explanation.

  The dissolved oxygen concentration was ***low in the bottom meter of the hypolimnion*** at the deep spot of the lake/pond on the July, August, and September sampling events. As stratified lakes/ponds age, oxygen becomes ***depleted*** in the hypolimnion (the lower layer) by the process of decomposition. In addition, depleted oxygen concentration in the hypolimnion of thermally stratified lakes/ponds typically occurs as the summer progresses. Specifically, the loss of oxygen in the hypolimnion results primarily from the process of biological breakdown of organic matter (i.e.; biological organisms use oxygen to break down organic matter), both in the water column and particularly at the bottom of the lake/pond where the water meets the sediment. When oxygen levels are depleted to less than 1 mg/L in the hypolimnion **(as it was this season and in many past seasons)**, the phosphorus that is normally bound up in the sediment may be re-released into the water column.

- **Table 11: Turbidity**
  Table 11 (Appendix B) lists the current year and historical data for in-lake and tributary turbidity. Turbidity in the water is caused by suspended matter, such as clay, silt, and algae. Water clarity is strongly influenced by turbidity. Please refer to the "Other Monitoring Parameters" section of this report for a more detailed explanation.

  As discussed previously, the turbidity of the hypolimnion (lower layer) sample was ***elevated*** on the June 30 and August 4 sampling events. This suggests that the lake/pond bottom may have been disturbed by the anchor or by the Kemmerer Bottle while sampling.

  In addition, the turbidity in the **Lyon Brook at Trussel Ridge** sample was ***elevated*** on the August 4 sampling event, which suggests that the stream bottom may have been disturbed while sampling or that erosion is occurring in this portion of the watershed.

DATA QUALITY ASSURANCE AND CONTROL

Annual Assessment Audit:

During the annual visit to your lake/pond, the biologist conducted a "Sampling Procedures Assessment Audit" for your monitoring group. Specifically, the biologist observed the performance of your monitoring group while sampling and filled out an assessment audit sheet to document the ability of the volunteer monitors to follow the proper field sampling procedures (as outlined in the VLAP Monitor's Field Manual). This assessment is used to identify any aspects of sample collection in which volunteer monitors are not following the proper procedures, and also provides an opportunity for the biologist to retrain the volunteer monitors as necessary. This will ultimately ensure that the samples that the volunteer monitors collect are truly representative of actual lake and tributary conditions.

Overall, your monitoring group did an ***excellent*** job collecting samples on the annual biologist visit this season! Specifically, the members of your monitoring group followed the proper field sampling procedures and there was no need for the biologist to provide additional training. Keep up the good work!

Sample Receipt Checklist:

Each time your monitoring group dropped off samples at the laboratory this summer, the laboratory staff completed a sample receipt checklist to assess and document if the volunteer monitors followed proper sampling techniques when collecting the samples. The purpose of the sample receipt checklist is to minimize, and hopefully eliminate, future re-occurrences of improper sampling techniques.

Overall, the sample receipt checklist showed that your monitoring group did an ***excellent*** job when collecting samples and submitting them to the laboratory this season! Specifically, the members of your monitoring group followed the proper field sampling procedures and there was no need for the laboratory staff to contact your group with questions, and no samples were rejected for analysis.

NOTES

- **Monitor's Note (6/9/03):** Sampling conducted after at least 2 weeks of overcast and rainy weather. Light rain and wind while sampling made it difficult to see Sechhi disk.
  - **(7/14/03):** There was little current at the inlet
  - **(8/4/03):** Heavy rain while sampling made it difficult to view Secchi disk. Sediment-laden runoff observed in channel at inlet. Cloudy water observed at Trussel Ridge.
  - **(8/11/03):** There has been over an inch of rain in the past two days.
  - **(8/25/03):** The hypolimnion white bottle leaked while in transit.
  - **(9/2/03):** Rain while sampling and overcast conditions

- **Biologist's Note (6/30/03):** The total phosphorous in the hypolimnion was elevated as was the turbidity. This suggests that the lake bottom was disturbed by the Kemmerer bottle or the anchor while sampling.
  - **(7/21/03):** No result for chlorophyll-a sample. Due to a computer malfunction while the sample was being run, data was lost. We apologize for this loss.
  - **(8/4/03):** The total phosphorous in the

hypolimnion was elevated as was the turbidity. This suggests that the lake bottom was disturbed by the anchor or Kemmerer bottle while sampling.

(8/11/03) The turbidity level and phosphorous concentration in the hypolimnion (lower layer) was elevated.

USEFUL RESOURCES

Acid Deposition Impacting New Hampshire's Ecosystems, ARD-32, NHDES Fact Sheet, (603) 271-3505, or www.des.state.nh.us/factsheets/ard/ard-32.htm.

Aquarium Plants and Animals: Don't leave them stranded. Informational pamphlet sponsored by NH Fish and Game, Aquaculture Education and Research Center, and NHDES (603) 271-3505.

Best Management Practices to Control Nonpoint Source Pollution: A Guide for Citizens and Town Officials, NHDES-WD 97-8, NHDES Booklet, (603) 271-3503.

A Boater's Guide to Cleaner Water, NHDES pamphlet, (603) 271-3503.

Camp Road Maintenance Manual: A Guide for Landowners. KennebecSoil and Water Conservation District, 1992, (207) 287-3901.

Comprehensive Shoreland Protection Act, RSA 483-B, WD-SP-5, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/sp/sp-5.htm.

Cyanobacteria in New Hampshire Waters Potential Dangers of Blue-Green Algae Blooms, NHDES Fact Sheet, (603) 271-3505, or www.des.state.nh.us/factsheets/wmb/wmb-10.htm.

Erosion Control for Construction in the Protected Shoreland Buffer Zone, WD-SP-1, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/sp/sp-1.htm

Impacts of Development Upon Stormwater Runoff, WD-WQE-7, NHDES Fact Sheet, (603) 271-3503, or www.des.state.nh.us/factsheets/wqe/wqe-7.htm

Iron Bacteria in Surface Water, WD-BB-18, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/bb/bb-18.htm

Is it Safe to Eat the Fish We Catch? Mercury and Other Pollutants in Fish, NH Department of Health and Human Services pamphlet, 1-800-852-3345, ext. 4664.

Lake Protection Tips: Some Do's and Don'ts for Maintaining Healthy Lakes, WD-BB-9, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/bb/bb-9.htm.

Management of Canada Geese in Suburban Areas: A Guide to the Basics, Draft Report, NJ Department of Environmental Protection Division of Watershed Management, March 2001, www.state.nj.us/dep/watershedmgt/DOCS/BMP_DOCS/Goosedraft.pdf.

Proper Lawn Care In the Protected Shoreland, The Comprehensive Shoreland Protection Act, WD-SP-2, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/sp/sp-2.htm.

Road Salt and Water Quality, WD-WMB-4, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/wmb/wmb-4.htm.

Sand Dumping - Beach Construction, *WD-BB-15*, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/bb/bb-15.htm.

Swimmers Itch, *WD-BB-2*, NHDES Fact Sheet, (603) 271-3503 or *www.des.state.nh.us/factsheets/bb/bb-2.htm.*

Through the Looking Glass: A Field Guide to Aquatic Plants. North American Lake Management Society, 1988, (608) 233-2836 or www.nalms.org.

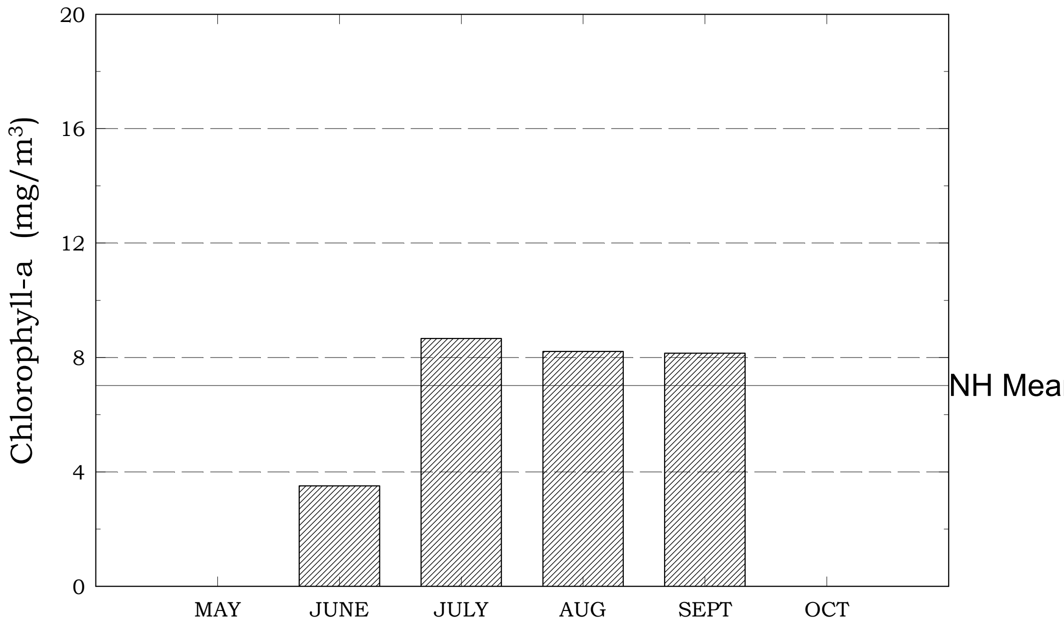
Weed Watchers: An Association to Halt the Spread of Exotic Aquatic Plants, WD-BB-4, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/bb/bb-4.htm.

APPENDIX A

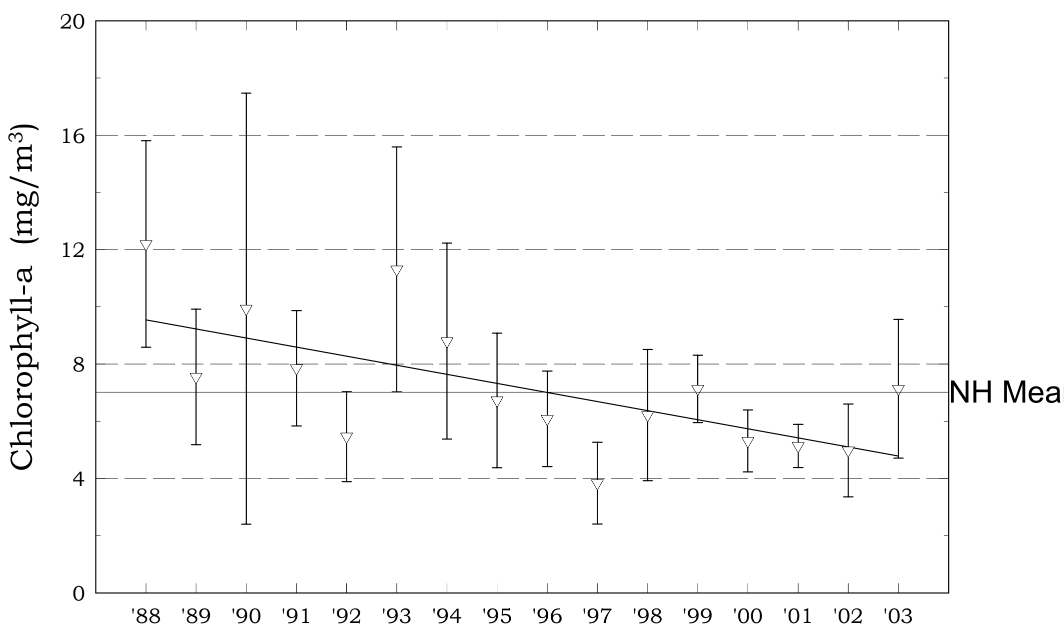
GRAPHS

Kezar Lake, North Sutton

Figure 1. Monthly and Historical Chlorophyll-a Results



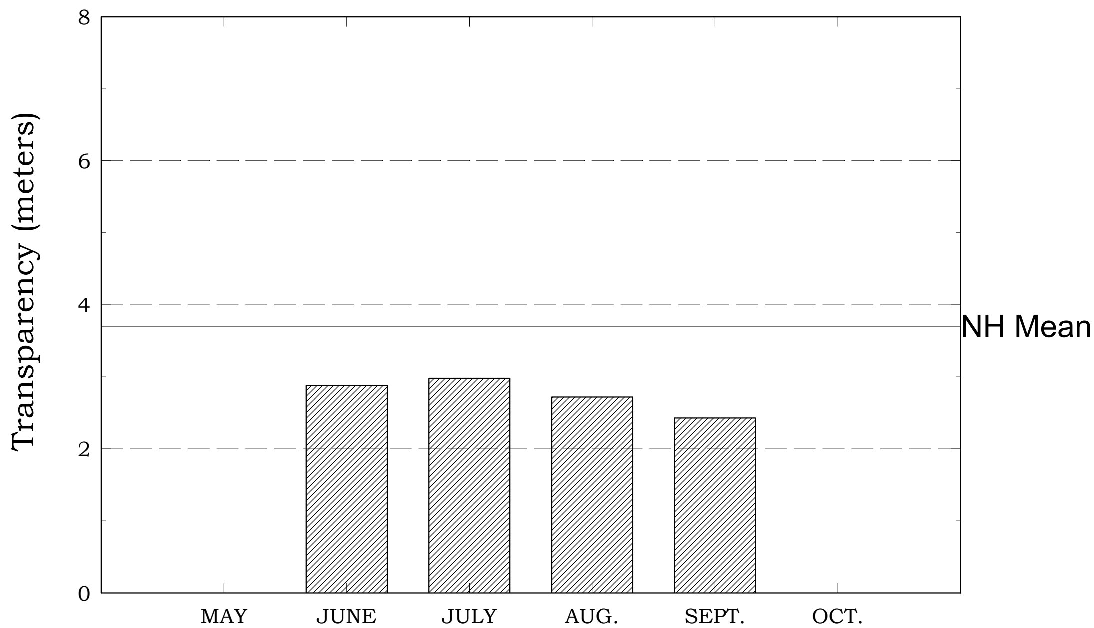
2003 Chlorophyll-a Results



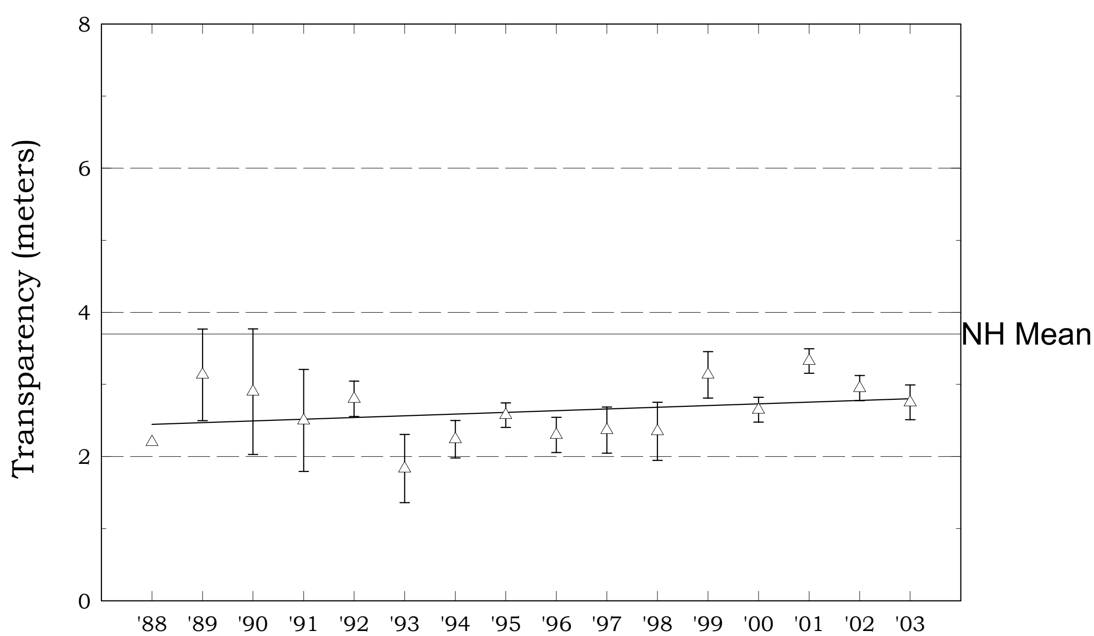
Historical Chlorophyll-a Results

Kezar Lake, North Sutton

Figure 2. Monthly and Historical Transparency Results



2003 Transparency Results



Historical Transparency Results

Kezar Lake, North Sutton

Figure 3. Monthly and Historical Total Phosphorus Data.